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Amphibian & Reptile Conservation
13(2) [Special Section]: 61–67 (e195).

Geographic range extension of Speke's Hinge-back Tortoise *Kinixys spekii* Gray, 1863

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***Abstract.—Kinixys spekii* has a wide distribution range across sub-Saharan Africa, having been reported from Angola, Botswana, Burundi, the Democratic Republic of the Congo, eSwatini, Kenya, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia, and Zimbabwe. *Kinixys spekii* inhabits savannah and dry bushveld habitats and was previously considered an inland species. However, recent records suggest a more extensive geographical distribution. Here, we provide genetically verified records for Angola, South Africa, and Mozambique, and discuss reliable sightings for Rwanda. These new records extend the range significantly to the east and west, and provide evidence for the occurrence of this species along the coast of the Indian Ocean in South Africa and Mozambique.**

Keywords. Africa, Angola, chelonians, distribution, Mozambique, Reptilia, Rwanda, Testudinidae

Citation: Ihlow F, Farooq HM, Gvoždík V, Hofmeyr MD, Conradie W, Campbell PD, Harvey J, Verburgt L, Fritz U. 2019. Geographic range extension of Speke's Hinge-back Tortoise *Kinixys spekii* Gray, 1863. *Amphibian & Reptile Conservation* 13(2) [Special Section]: 61–67 (e195).

Received: 17 July 2019; **Accepted:** 28 September 2019; **Published:** 6 November 2019

The genus *Kinixys* currently comprises eight species (Kindler et al. 2012; TTWG 2017): *K. belliana* Gray, 1830; *K. erosa* (Schweigger, 1812); *K. homeana* Bell, 1827; *K. lobatsiana* Power, 1927; *K. natalensis* Hewitt, 1935; *K. nogueyi* (Lataste, 1886); *K. spekii* Gray, 1863; and *K. zombensis* Hewitt, 1931. Two of these species are confined to rainforest habitats (*K. erosa, K. homeana*), while one is restricted to north-western Africa (*K. nogueyi*), and the remaining five occupy savannah and forest habitats in eastern and south-eastern Africa.

Speke's Hinge-back Tortoise, *Kinixys spekii,* has an extensive geographical distribution range, spanning twelve countries, from southern Kenya southward to eSwatini (formerly Swaziland), southern Mozambique, and north-eastern South Africa, where it reaches its southernmost limit (Boycott and Bourquin 2000; Branch et al. 1995; Broadley 1989a; Spawls et al. 2004, 2018; TTWG 2017). The species' westward range extends across Zimbabwe, Zambia, and northern Botswana into the Zambezi (formerly Caprivi) region of Namibia (Broadley 1989a, 1993; Jacobsen et al. 1986; Pienaar et al. 1983; TTWG 2017). According to Broadley (1989a,b, 1993), *K. spekii* is confined to the inland parts of southern and central Africa, inhabiting the eastern plateau slopes, while the range of *K. zombensis* extends along the East African coastal plain from Kenya to the KwaZulu-Natal Province of South Africa. However, a few records from Kenya (Watamu, 3.34250°S, 40.02740°E; in the vicinity of Kilifi, voucher specimen in the collection of the Yale Peabody Museum of Natural History YPM HERR 014516) suggest that the range of *K. spekii* reaches the northern coastal areas as well. Since some photographs of tortoises from Watamu shown in Spawls et al. (2004, 2018) morphologically resemble *K. zombensis* rather than *K. spekii,* this record requires verification.

In terms of habitat, *K. spekii* has been recorded from savannah, tropical bushveld, tropical savannah, sour bushveld, and the thornveld of the Lebombo Plateau

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(Boycott 2001; Boycott and Bourquin 2000; Branch 2008). According to Broadley (1989a), this species prefers moist savannah woodlands, such as Miombo and Mopane (woodlands dominated by *Brachystegia* and *Colophospermum* species, respectively), but also occurs in drier deciduous woodlands and thickets dominated by *Vachellia* (until recently *Acacia*; Kyalangalilwa et al. 2013) and *Commiphora* in the north-eastern part of its range (Broadley 1989a).

For the present contribution, records for *K. spekii* were compiled from the scientific literature and museum collections, and supplemented with a few selected sightings from the online Virtual Museum Database iNaturalist (https://www.inaturalist.org) to discuss the distribution range of *K. spekii*. Several new and genetically verified records from Angola, South Africa, and coastal Mozambique are also presented, which extend the species' known distribution range considerably. Genetic verification relied on an mtDNA sequence coding for the partial NADH dehydrogenase subunit 4 (ND4) and adjacent tRNAs.

Unfortunately, online databases and data aggregators are often compromised by incorrect identifications and outdated taxonomy, and either provide no photographic vouchers or ones that are unsuitable for facilitating verification before using the data. Nevertheless, two photographic vouchers deposited with iNaturalist (https://www.inaturalist.org/observations/18255494, https://www.inaturalist.org/observations/1047117) could clearly be assigned to *K. spekii*, based on characteristic coloration patterns and shell shape. These records provide evidence that the species occurs as far north-west as Nyagatare (1.42321°S, 30.63027°E) and Akagera (1.55162°S, 30.60760°E) in Rwanda, which is in accordance with Spawls et al. (2004, 2018), who reported isolated records for *K. spekii* from Akagera, the Ruzizi Plain, and the southern Kerio Valley in eastern Rwanda. To the east, two genetically verified *K. spekii* (Museum of Zoology, Senckenberg Dresden, Tissue Collection: MTD 17106, 17107; European Nucleotide Archive accession numbers: LR723010, LR723011) were sampled and released by Luke Verburgt in February 2014 on the Afungi Peninsula, Cabo Delgado Province, coastal Mozambique (10.81939°S, 40.54842°E; but see below). In addition, four genetically verified adult *K. spekii* (MTD 20463, 20464; LR723016, LR723017) were sampled and released by Harith M. Farooq within a 10 km radius of the Lúrio University in Pemba, Cabo Delgado Province, Mozambique (12.97540°S, 40.57083°E) in 2014. An adult female (12.97615°S, 40.10205°E) and an adult male tortoise (12.99333°S, 39.94861°E) were sampled and released by William R. Branch in March 2017 in Ancuabe, Cabo Delgado Province, Mozambique, and both were genetically verified to represent *K. spekii* (MTD 20463-20464; LR723016-7). In the west, a genetic sample (SANBI 2126; LR723018) collected by Thomas Branch in October 2008 shows that *K. spekii* also occurs near Saurimo, Lunda Sul Province, Angola (9.39694°S, 20.43194°E).

With the exception of the tortoises from the Afungi Peninsula, all specimens could unambiguously be identified morphologically as *K. spekii* based on the following characteristics: beak unicuspid, carapace with well-developed hinge, carapace distinctly depressed, and posterior marginal scutes not recurved or serrated. Previous records for Mozambique were limited to the southwest (Boycott and Bourquin 2000), the vicinity of Ressano Garcia, southern Mozambique (Broadley 1989b), and the Maputo Elephant Reserve situated along the coast of southern Mozambique (voucher specimen in the collection of the Ditsong National Museum of Natural History TM 41761; Broadley 1993; Fig. 1). To the south, samples collected in the KwaZulu-Natal Province, South Africa, were genetically verified as *K. spekii* (MTD 13594 from Mkhuze Game Reserve; LR723019; MTD 7457 from the vicinity of Mtubatuba; HE662316). Previously, *K. spekii* was only known from the extreme northern border of the province, adjacent to eSwatini and Mozambique (Bourquin 2004; Boycott 2014).

The abovementioned records enlarge the known geographical distribution range of *K. spekii*, but also demonstrate that the species' distribution range is still incompletely known. Unfortunately, morphological traits overlap between *Kinixys* species, making species identification in potential zones of sympatry extremely difficult. For instance, *K. spekii* co-occurs with *K. zombensis* in the Maputo Elephant Reserve in Mozambique, and the Ndumo Game Reserve in South Africa. In the Waterberg area of South Africa *K. spekii* is found close to *K. lobatsiana* populations, and it was recorded together with *K. natalensis* in the vicinity of Jameson's Drift, in the Lebombo Mountains in KwaZulu-Natal as well as in the area of Hoedspruit. In these areas, hybridization is possible, which further complicates identification. For example, the two tortoises collected from the Afungi Peninsula in northern Mozambique morphologically resemble *K. zombensis* (Fig 3; domed carapace, radial coloration pattern), but their mtDNA sequences match those of *K. spekii*, suggesting hybridization. Additional genetic studies using nuclear genes are required to verify their putative hybrid status. However, if there is no evidence for a hybrid identity in these tortoises, then the morphological characters thought to be diagnostic for discerning *K. spekii* and *K. zombensis* would be seriously challenged. Moreover, the characteristic coloration patterns commonly used to distinguish between *Kinixys* species tend to fade with age, rendering older tortoises more or less uniformly colored (Branch 2008; Broadley 1993; Fig. 2). Hence, hinge-back tortoises are frequently misidentified. Genetic verification of specimens which were morphologically determined by renowned African herpetologists revealed misidentification rates ranging from 2% for *K. zombensis* to 66% for *K. natalensis* (F. Ihlow and U. Fritz unpub.

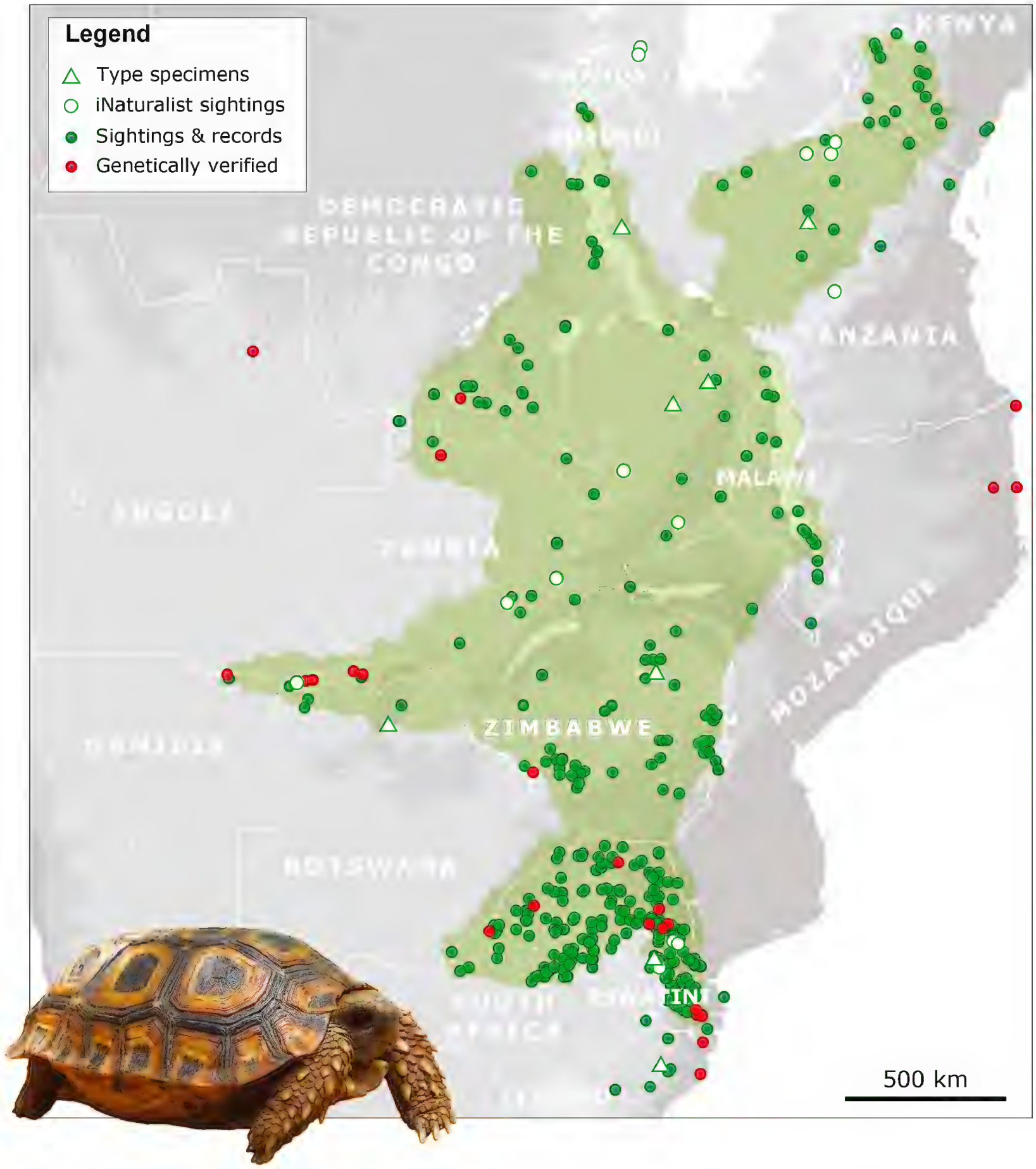

Fig. 1. Known distribution of *Kinixys spekii*. Range according to TTWG (2017) is displayed as green shaded area. Open circles refer to iNaturalist observations, while solid green circles represent literature records and specimens deposited in scientific collections. Solid red circles correspond to genetically verified records, and triangles to name-bearing type specimens of *Kinixys spekii* and its synonyms.

data). While older, uniformly colored *K. lobatsiana* are mainly confused with *K. spekii* and vice versa, young *K. spekii* are frequently confused with *K. natalensis* (Fig. 2). The most reliable morphological trait allowing distinction between *K. natalensis* and young *K. spekii* is the tricuspid beak of *K. natalensis*, whereas *K. spekii* has a unicuspid beak. Old uniformly colored *K. lobatsiana* can be distinguished from *K. spekii* based on the posterior shell rim, which is serrated in *K. lobatsiana* and smooth in *K. spekii* (Fig. 2).

The high misidentification rates show that the established morphological characters for species determination are insufficient and call into question the reliability of published records, photographic vouchers, and even the identification of specimens (including name-bearing type specimens) housed in scientific collections. Given that the putative distribution ranges (TTWG 2017), which represent an essential tool for the conservation and management of these species, also largely rely on collection databases and morphologically identified individuals, these should be treated with caution.

To ensure correct species identification of challenging specimens, molecular genetic verification is strongly recommended until more robust morphological characters have been revealed. Photographic vouchers should include dorsal, ventral, and lateral views to facilitate accurate species identifications. For *K.*

Fig. 2. Top: Lateral views of adult *Kinixys lobatsiana* (left) and *K. spekii* (right). **Center**: Ventral views of young (SCL 106 mm) and adult (SCL 161 mm) *K. lobatsiana* (left) and young (SCL 131 mm) and adult (SCL 151 mm) *K. spekii* (right). Note the strongly serrated posterior marginal scutes in *K. lobatsiana* compared to the smooth carapace rim in *K. spekii*. **Bottom:** Lateral views of adult *K. natalensis* (left) and young *K. spekii* (right). *Photos: James Harvey and Flora Ihlow.*

natalensis additional voucher photographs showing the tricuspid beak should be taken.

Acknowledgements.—We are grateful to the following collections, and their curators and managers, for providing data and photographs of specimens or access to their collections: Shiela Broadley (National Museum Zimbabwe), Lauretta Mahlangu (Ditsong National Museum of Natural History), Garin Cael (Royal Museum for Central Africa), and José Rosado (Museum of Comparative Zoology). We further thank Marius Burger and Steve Spawls, who provided data, pictures, or genetic samples, and the locals who kindly permitted sampling on their properties. We are grateful to Anders G.J. Rhodin for sharing a dataset of occurrence records compiled for the latest TFTSG checklist. In addition, FI thanks Anja Rauh and Anke Müller (Senckenberg Dresden) for assistance during laboratory work. All genetic analyses were done at the molecular genetic laboratories of the Museum of Zoology (SGN-SNSD-Mol-Lab), Senckenberg Dresden. FI profited from a Margarethe Koenig scholarship from the Zoological Research Museum Alexander Koenig. In addition, research by FI is supported by the German Science Foundation (DFG IH 133/1–1). Fieldwork was partly supported through the Mapula Trust awarded to MDH.

Fig. 3. Top: Lateral views of the putative hybrids from the Afungi Peninsula, Cabo Delgado Province, Mozambique, which have mtDNA sequences of *Kinixys spekii* but morphologically resemble *K. zombensis*. **Bottom:** Lateral views of genetically verified *K. zombensis* from KwaZulu-Natal Province, South Africa. *Photos: Luke Verburgt and Flora Ihlow.*

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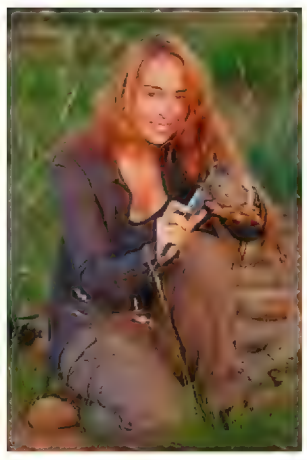

Flora Ihlow is a German herpetologist (Dr. rer. nat.) presently working at the Senckenberg Natural History Collections, Dresden, Germany. For the past 10 years, Flora's research has mainly focused on the herpetofauna of Southeast Asia, in particular on the ecology, systematics, and distribution of chelonians. She has published numerous scientific papers on these topics. After graduating from the Rheinische Friedrich-Wilhelms-Universität (Bonn, Germany), Flora joined the phylogeography group of Senckenberg Dresden in 2017 as a post doc to study the systematics and distribution of chelonians from southern Africa. Flora is a member of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group (TFTSG).

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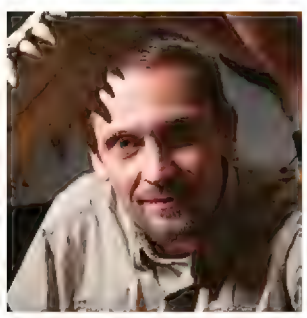
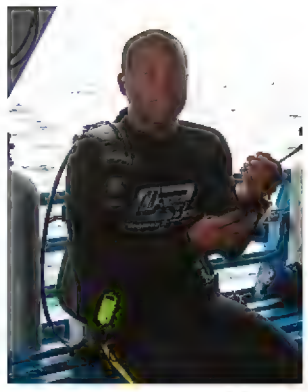


Václav Gvoždík is a herpetologist based at the Institute of Vertebrate Biology of the Czech Academy of Sciences. Václav is interested in the phylogeography, diversity, and evolution of amphibians and reptiles of the Western Palearctic and sub-Saharan Africa. In Africa, he has mostly worked in lowland and montane rainforests, and in recent years mainly in the rainforests of the Congo Basin. While Václav has been studying various groups of herpetofauna, anurans have been his main focal group.

Margaretha D. Hofmeyr is Professor Emeritus at the Biodiversity and Conservation Biology Department, University of the Western Cape, South Africa. Margaretha is an ecophysiologist by training and first studied large ungulates before switching to chelonians. Her ecophysiological studies revealed that South African tortoises have many unique characteristics, which stimulated her interest in their genetic diversity and systematics. Margaretha has published extensively on the ecology and phylogeography of sub-Saharan tortoises and turtles, and she is closely involved in several conservation projects for threatened tortoises. This work resulted in her being awarded the 2015 Sabin Turtle Conservation Prize. Margaretha is a member, and Regional Vice-Chair for Africa, of the IUCN/SSC TFTSG and she coordinated the 2014 and 2018 Red List Assessments for South African tortoises and freshwater turtles.

Werner Conradie holds a Masters in Environmental Science (M. Env. Sc.) and has 12 years of experience with the southern African herpetofauna, with his main research interests focusing on the taxonomy, conservation, and ecology of amphibians and reptiles. Werner has published numerous principal and collaborative scientific papers, and has served on a number of conservation and scientific panels, including the Southern African Reptile and Amphibian Relisting Committees. He has undertaken research expeditions to many African countries including Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Zambia, and Zimbabwe. Werner is currently the Curator of Herpetology at the Port Elizabeth Museum (Bayworld), South Africa.



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Luke Verburgt is a specialist consulting herpetologist working throughout Africa, with his professional and scientific research experience extending over 16 years. Luke has published 18 internationally recognized scientific papers to date on topics including herpetology, evolutionary biology, ecological physiology, and animal behavior. His professional career covers biodiversity-related work on projects throughout Africa and its islands (Angola, Botswana, Cameroon, Côte d'Ivoire, Guinea, Lesotho, Liberia, Madagascar, Malawi, Mali, Marion Island, Mozambique, Namibia, South Africa, Uganda, and Zimbabwe). Luke currently co-owns and co-directs the Enviro-Insight consultancy (http://www.enviro-insight.co.za) where he fulfills roles as Director, senior ecological specialist, project manager, software developer, and GIS specialist.

Uwe Fritz is the head of the Museum of Zoology, Senckenberg Natural History Collections at Dresden, Germany, and Extraordinary Professor for Zoology at the University of Leipzig, Germany. Uwe has worked for many years on the taxonomy, systematics, and phylogeography of turtles and tortoises, and has also studied to a lesser extent snakes and lizards. He is particularly interested in hybridization patterns and gene flow in contact zones of distinct taxa. Uwe has authored or co-authored numerous scientific articles, mainly in herpetology, and has also edited various proceedings and books, among them the two turtle volumes of the *Handbook of Amphibians and Reptiles of Europe*.